

THE GENUS *TROMBICULA* BERLESE, IN AMERICA AND THE ORIENT.

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The recent demonstration that the well-known "kedani," or chigger mite of Japan, is the active agent in the transmission of a deadly human disease ("tsutsugamushi" disease, or flood fever) has brought the whole chigger mite group under the suspicion of being one of possibly great importance in the carrying of disease among man and domesticated animals. The further rearing of the adults of this chigger in 1916 by two groups of Japanese workers, and proving them to be *Trombicula*s has paved the way for an investigation into the taxonomy and biology of all the species of this genus. Such an investigation is now of prime importance, for we may well presume that the other species of the group are not so vastly different in their habits from those of the deadly "kedani."

During the summer of 1919 the writer had the good fortune to meet Dr. M. Miyajima and to study with him some of the different members of the genus. At first it appeared to us that our only described species, *Trombicula splendens* Ewing, was a synonym of the Japanese form, the adult of the "kedani," which Dr. Miyajima holds to be *Trombicula coarctata* Berlese. A more careful study of the type of *T. splendens*, as well as the paratypes in the American Museum of Natural History, has shown that the two species are quite distinct, as will be made evident in this paper. While Dr. Miyajima was yet in this country another *Trombicula* species was discovered by the writer near Washington, D. C. This species is described in the present paper for the first time.

When examined superficially all the known species of the genus *Trombicula* appear remarkably alike. They vary in length from 1 to 1.6 mm. in most cases and are always well clothed with strongly pectinate setae. The color varies from that of human flesh to a scarlet vermilion, but usually would be called a reddish orange. Their proportions are almost identical; legs moderate, body stout, cephalothorax small, the abdomen deeply constricted; this latter character at once distinguishing them from all other Trombidiidæ.

A more careful examination of the microscopical structures reveals to us, however, that the species can be easily separated. For this purpose Berlese has already used; size, the presence or absence of the eyes, variations in the relative lengths of the front tibiæ and tarsi, the ratio between the length and breadth of the front tarsi, and to a limited extent the nature of the body setæ and a few other structures. Of these characters the selection of size appears to be rather unfortunate, as there is not only a remarkable uniformity in size among some of the adults, but the nymphs, which are smaller than the adults, are so easily confused with the latter. The use of the ratio existing between the lengths of the front tibiæ and tarsi is good and in this paper will be expressed by taking the length of the tibia as unity. The following characters should be added to those given by Berlese as being of much importance in specific diagnosis: The structure and shape of the crista, especially the expanded portion, or pseudostigmatic area; the position, size and structure of the sense hairs, or pseudostigmatic organs; the structure of the body setæ, especially should it be noticed whether the barbs extend to the tip or not, their relative length when present at the tip, and also the thickness of the seta at its tip.

THE "AKAMUSHI" OR "KEDANI" MITE.

Through the generosity of Dr. Miyajima, the writer has examined a good series of the adults of the "kedani." In general appearances these specimens are almost exactly like our *Trombiculas*. However, when we examine those characters that alone are of specific importance, we find that the Japanese *Trombicula* is quite distinct from both our species. A description of the "kedani" adult follows in which only those characters that are of specific importance are given.

Trombicula coarctata Berlese. Color of alcoholic specimens almost white, but live ones are "light reddish ochre" (Miyajima and Okumura). Body well clothed with strongly pectinate, whitish setæ, showing a tendency to be grouped in longitudinal rows. Cephalothorax triangular in outline. Eyes wanting, also vestiges wanting. Crista extending for the whole length of cephalothorax; carina straight and extending from the anterior end of crista into the pseudostigmatic area; posterior lobes of this area more or less angulate and situated directly behind the pseudostigmatic pores. Pseudostigmatic organs, or sense hairs, delicate, about as long as the crista and each provided with a few delicate barbs on the distal half, the number of barbs present

being variable. Palpi each with four inner tibial spines, the longest of which is equal to about half the length of the claw. Thumb of palpus not surpassing the claw. Abdomen with the usual constriction. Setæ of abdomen much longer on the posterior margin than on the shoulders. Each seta is situated on a pedicel bearing disc, is strongly pectinate and usually stoutest at its tip, where the barbs are somewhat less conspicuous. Legs rather stout, the anterior pair much the longest and largest, the posterior pair reaching the tip of the abdomen. Tarsus I is one and sixty-one hundredths times as long as tibia I and is much thicker dorso-ventrally than laterally. Tarsus IV about one and a fourth times as long as tibia and with the outer claw slightly smaller and more strongly curved than the inner. Length usually from 1.00 mm. to 1.10 mm., but varies considerably; breadth from 0.50 mm. to about 0.65 mm.

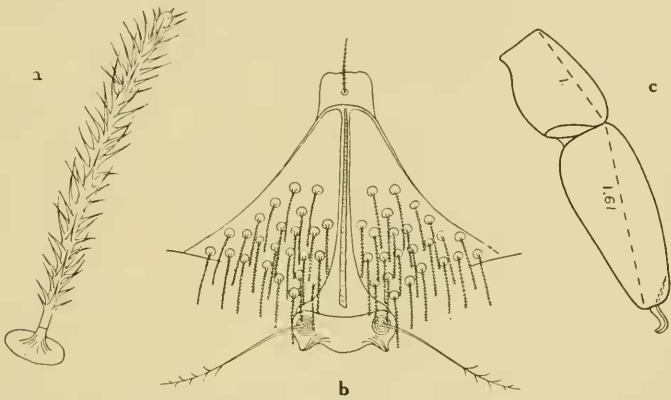


Fig. 1. *Trombicula coarctata* Berlese; a, seta from dorsum of abdomen; $\times 900$; b, dorsal view of cephalothorax, $\times 375$; c, last two segments of right front leg, side view, $\times 125$.

Several individuals received from Dr. Miyajima from Japan.

This species strongly resembles *T. splendens* Ewing, when examined superficially, but in reality is quite distinct. It is a blind species, whereas *T. splendens* has eyes, which, however, are not strongly developed and are easily overlooked. The posterior lobes of the pseudostigmatic area in the Japanese species are angulate and situated directly behind the pseudostigmata. In *T. splendens* these are evenly rounded and are situated approximate at the median line. In *T. coarctata* the pseudostigmatic organs arise from the pseudostigmata and are distinctly pectinate; in *T. splendens* these structures arise *inside* the pseudostigmata and are either simple or but very slightly pectinate. The body setæ of the Japanese species are

frequently thickened at the tips. This is not true of *T. splendens*. There are several other minor differences between the two species, such as a difference in the tarsus-tibia ratio in leg I.

More is known concerning the biology and life history of this chigger mite than any other, due to the very extensive researches of several Japanese workers, yet much remains to be learned concerning it. Dr. Miyajima holds that it is a vegetable feeder, and Miyajima and Okumura state: "In nature, both the nymph and the adult seem to live on the juice of plants, e. g., reed (*Imperata arundinacea* Cyr.), daisy (*Artemisia vulgaris* L.), etc." If this species is a true vegetable feeder in the adult state, it is entirely different in this respect from all other species of Trombidiidæ, whose feeding habits are known.

T. coarcta is found in many places in Japan and doubtless occurs in several other oriental countries. Berlese described the species from South America, where it is known to occur in Paraguay and Argentine Republic. Indications at present are that it has a wide distribution in subtropical and temperate countries.

THE GENUS TROMBICULA IN THE EAST INDIES.

The East Indies have long had a notorious reputation for their chiggers. Many are the tales that various travelers have related in regard to their attacks. As early as 1869 Alfred Russell Wallace wrote of them, saying they were "worse than mosquitoes, ants and every other pest, * * * ." It was not, however, until 1912 that we had any extensive scientific description of the chigger larvæ of these islands. In this year appeared Oudemans' extended work on "Die bis jetzt bekannten Larven von Trombidiidæ und Erythraeidæ," in which he describes and speaks at length of two species known to attack man in these islands. The same year appeared the extended work of the eminent Italian entomologist, Antonio Berlese, on the "Trombidiidæ." In this work Berlese gives descriptions of two Trombiculas from Java; one as *T. mediocris* and one as *T. minor*. According to Berlese these two species are closely related, yet he held them to be distinct, largely because *minor* was considerably smaller, had shorter abdominal setæ and the anterior tarsi were more conical in shape.

After rearing the adult of the "kedani" mite and demonstrating the nymphal characters in that species, Dr. Miyajima came to the conclusion that *T. minor* was only a nymph of *T. mediocris*. A careful study of the nymphal characters as given by Drs. Miyajima and Okumura certainly lends weight to Miyajima's opinion. Of special importance is their demonstration that the "kedani" nymph has only two palpal spurs, while in the adult there are four. If we grant the synonymy of these two species, the name *minor* has precedence over *mediocris* because of priority. This is unfortunate, as *mediocris* is one of the largest species of the genus, yet according to the application of the priority rule, loses this name to become *minor*.

T. minor (mediocris) Berlese is found outside the East Indies as was shown by Drs. Kitashima and Miyajima, who received material from Formosa, sent by Herrn Hatori. In their extended paper, "Studien ueber die Tsutsugamushi, Krankheit," they give an excellent figure of *minor (mediocris)* and make comparisons between this species and the adult of the "kedani" mite, held to be *coarctata*.

In the orient then we have, as far as is known, two *Trombicula* species, *T. coarctata* and *T. minor (mediocris)*. One of these is known at present in the orient only from Japan, the other from Java and Formosa. It may be added that *T. minor* has the body clothed with shorter, and colored setæ, which are of about equal length over all of the dorsal part of the abdomen, while *T. coarctata* has longer and colorless hairs on the dorsum of the abdomen, and those around the posterior margin are much longer than those on the shoulders.

OUR TROMBICULAS.

As in the orient, so in the United States we have two *Trombicula*s. One of these was described by the writer as *T. splendens* in 1913, from Wisconsin, and the other was discovered during the summer of 1919 in Virginia and Maryland. *T. splendens* resembles *T. coarctata* in having the long, colorless body setæ, which are much longer on the posterior margin than on the shoulders, while our other species resembles Berlese's *minor* in having the shorter, colored and almost uniform body setæ. The former species is here described:

Trombicula splendens Ewing. As indicated in its specific name, this species has a splendid appearance, which is given to it by its wonderful coat of feathery hairs. It is more beautiful than our other species, yet it can hardly be said to be more attractive than the Japanese "kedani" adult. The cephalothorax is triangular in outline, with the crista extending for its entire length. Carina of crista much reduced and chiefly confined to the pseudostigmatic area, which is triangular in general outline. Posterior lobes of pseudostigmatic area evenly rounded behind and situated approximate to the median line. Pseudostigmatic hairs, or sense setae, simple or with exceedingly inconspicuous barbs and situated inside of pseudostigmata and, therefore, not arising from them. Eyes just lateral and posterior to pseudostigmata. They are not well developed, the corneas being thin and inconspicuous.

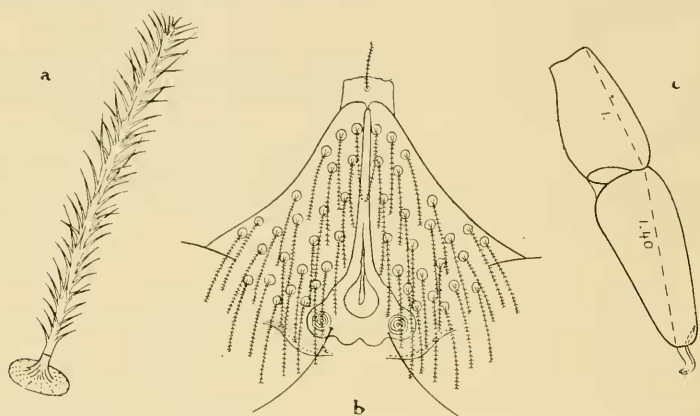


Fig. 2. *Trombicula splendens* Ewing; a, seta from dorsum of abdomen, $\times 900$; b, dorsal view of cephalothorax, $\times 375$; c, last two segments of front leg, side view, $\times 125$.

Palpi longer than first two segments of leg I; thumbs cylindrical and not exceeding the palpal claw. Abdomen strongly constricted as usual and well clothed with long and strongly pectinate setae. Each seta arises from its pedicellate disc and is provided with barbs for its entire length; at its tip the barbs somewhat smaller; tip never thickened. First pair of legs as long as body, excluding the beak; tarsus somewhat cone-shaped, one and forty hundredths times as long as tibia. Second and third pair of legs about two-thirds as long as first pair. Last pair of legs just reaching the tip of the abdomen. Length of body, including beak, about 1.00 mm.; width about 0.56 mm.

From Portage, Wisconsin, September 2, 1909; on under side of stones on ground; by the writer.

About half a dozen adults of this species were taken. The type is in the writer's private collection, but the paratypes are deposited in the American Museum of Natural History, New

York City. The three drawings here given are all made from the type.

This *Trombicula* is quite distinct from *T. coarctata*, as has already been pointed out. It is at once distinguished from the species found in Maryland and Virginia by having only vestigial eyes, the pseudostigmatic organs arising inside of the pseudostigmata, and by having the body setæ much longer and colorless. Little is known of its habits. Since all the specimens were found above the soil and the species has not completely lost its eyes, it may be inferred that it is not subterranean in habits.

***Trombicula cinnabaris* n. sp.** Color of live adults scarlet vermilion, or cinnabar. Cephalothorax triangular and with the crista extending for its entire length. Carina of crista extending from the anterior end of the latter as a straight ridge to about the middle of the triangular, pseudostigmatic area. Posterior lobes of pseudostigmatic area evenly rounded and near the median line. Pseudostigmatic organs arising from pseudostigmata and provided with a few minute barbs on their posterior margins near their tips. Eyes well developed, very near the pseudostigmata and with thick and strongly curved corneas. Palpi armed with three tibial spurs, the longest of which is less than half as long as the palpal claw; thumb of palpus not swollen and not surpassing the palpal claw. Chelicerae with lower chela sharp and provided with about two dozen backwardly directed teeth; upper chela represented by a chitinous tubercle-like knob. Abdomen clothed with the usual setæ, which are but slightly, if at all, longer on the posterior border than on the shoulders, and have the barbs smaller at the somewhat tapering tip. Legs about as usual, the first pair being much the largest and longest. The tarsi of this pair are one and forty-seven hundredths times as long as the tibiae. Posterior legs reaching to the tip of abdomen. Length of medium-sized specimen, 0.92 mm.; width, 0.52 mm.

From East Falls Church, Virginia; summer of 1919; by the writer. From North Beach, Maryland; summer of 1919; by the writer. Found both in the soil and on the surface of soil under dead leaves and bits of decaying vegetable matter.

Described chiefly from the type which was taken at East Falls Church, Virginia, August 21, 1919, from soil of a blackberry patch which was heavily infested with chiggers. This, our Eastern *Trombicula*, is most closely related to *T. minor* (*mediocris*) Berlese. It is differentiated from Berlese's species by having only three spines on the palpus instead of four and in being considerably smaller.

The adults of *T. cinnabaris* probably spend most of their time on the surface of the ground, where they go about under

the dead leaves and grass in search of food. They appear to feed chiefly upon juices of small arthropods, either recently killed or in a quiescent instar. One individual was kept for many weeks in the finest of condition in a small vial with this kind of a diet. This individual was never observed to enter

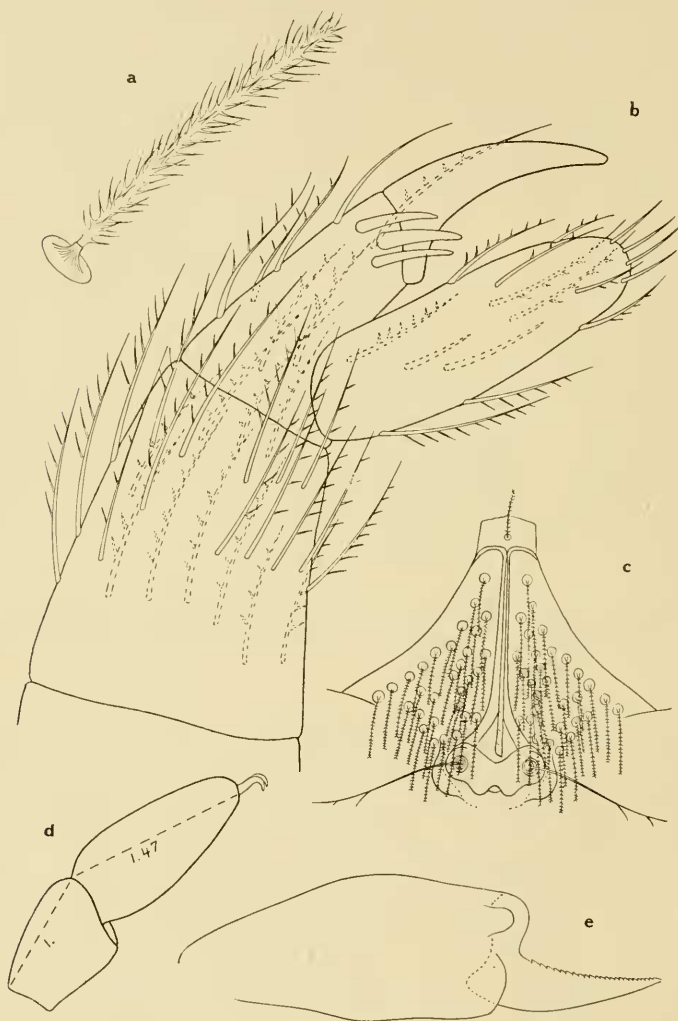


Fig. 3. *Trombicula cinnabaris* n. sp.; a, seta from dorsum of abdomen, $\times 900$; b, last three segments of left palpus from inside, $\times 900$; c, dorsal view of cephalothorax, $\times 375$; d, last two segments of right front leg, side view, $\times 125$; e, left chelicera from inside, $\times 800$.

or burrow into the sand provided for it in the breeding vial. Individuals thrive only with a very moist atmosphere, even saturation is not injurious to them. Their coats of feathery setæ keep their bodies dry. When placed in water they come rapidly to the top and can walk about over the surface.

In order to enable different workers to determine species of the genus and in order to call attention to certain characters which alone are of value in separating the different species, a key to all those known up to the present is here given.

KEY TO THE SPECIES OF THE GENUS *TROMBICULA* BERLESE.

- A. Eyes present and well developed; setæ of body but slightly longer on the posterior margin than on the shoulders, and colored.
 - B. Palpus armed with four spines on the inner side of tibia; adults about 1.5 mm. in length.....*T. minor* Berlese
 - BB. Palpus armed with only three spines on the inner side of tibia; adults not over 1.0 mm. in length.....*T. cinnabaris* n. sp.
- AA. Eyes vestigial or absent; setæ of body considerably longer on the posterior margin than on the shoulders.
 - B. Anterior tarsi much less the three times as long as broad; palpus armed with four accessory spines.
 - C. Posterior lobes of pseudostigmatic area larger, rounded and not behind the pseudostigmata; pseudostigmatic hairs arising inside of pseudostigmata; body hairs thinner at their tips than elsewhere.
T. splendens Ewing
 - CC. Posterior lobes of pseudostigmatic area smaller, more or less angulate and immediately behind the pseudostigmata; pseudostigmatic hairs arising from the bottoms of pseudostigmata; body hairs not thinner at their tips.....*T. coarctata* Berlese
 - BB. Anterior tarsi much more than three times as long as broad; palpus armed with three accessory spines.
 - C. Total length much more than 1.5 mm.; anterior tarsus over four times as long as broad.....*T. formicarum* Berlese
 - CC. Total length less than 1.5 mm.; anterior tarsus considerably less than four times as long as broad.....*T. canestrinii* Buffa

SYNONYMY.

The suggestion of the synonymy of *T. mediocris* with *T. minor* is received with some hesitancy, and as here given is based upon the study of the nymphal characters of the "kedani" by various Japanese workers. More data is needed in regard to the life history of *minor* before the question of synonymy can be settled with certainty.

***Trombicula minor* Berlese.**

- 1905. *Trombicula minor* Berlese. Acari Nuovi. Redia, Vol. II, pp. 155-156, Tav. XV, Figs. 4 and 4a.
- 1912. *Trombicula mediocris* Berlese. Trombidiidæ. Redia, Vol. VIII, pp. 93-94, Fig. 43.
- 1912. *Trombicula minor* Berlese. Trombidiidæ. Redia, Vol. VIII, pp. 94-95, Fig. 44.
- 1918. *Trombicula mediocris* Berlese. Kitashima and Miyajima: Studien Ueber die Tsutsugamushi-krankheit. Kitasato Archiv. Exp. Med., Vol. II, pp. 190-191, Taf. VIII, Fig. 2.

Trombicula splendens Ewing.

1913. *Trombicula splendens* Ewing. New Acarina, Part I. Bul. Am. Mus. Nat. Hist., pp. 113-114, Pl. VII, Fig. 5.

Trombicula coarctata (Berlese).

1888. *Trombidium coarctatum* Berlese. Acari Austroamericani. Bul. della Soc. Ent. ital. Anno. XX, p. 9, Tab. V, Fig. 5.
 1901. *Trombidium coarctatum* Berlese. Leonardi: Acari sud-american. Zool. Anz., Bd. XXV, p. 17.
 1912. *Trombicula coarctata* Berlese. Trombidiidæ. Redia, Vol. VIII, pp. 91-92, Fig. 42.
 1913. *Trombidium akamushi* Brumpt. Precis de Parasitologie. 2. edition. Paris.
 1915. *Microtrombidium akamushi* Brumpt. Hirst: On the Tsutsugamushi (*Microtrombidium akamushi*, Brumpt), Carrier of Japanese River-fever. Jour. Econ. Biol., Vol. X, p. 79 and Fig.
 1915. *Microtrombidium brumpti* Hirst. Jour. Econ. Biol., Vol. X, p. 79 and Fig.
 1916. *Leptotrombidium akamushi* (Brumpt). Nagayo, Miyagawa, Mitamura, and Imamura: Ueber die Imago und die Eier von Tsutsugamushi (Milbe). Ijishimbun, No. 958, Sept. 1916. (Nipp.). (From reference in foot-note by Miyajima and Okumura).
 1917. *Leptus akamushi* (Brumpt). Miyajima and Okumura. On the Life Cycle of the "Akamushi," Carrier of Nippon River Fever. Kitasato Arch. of Exp. Med., Vol. I, p. 13, Fig. 1 and Pls. I-III.
 1918. *Trombicula coarctata* Berlese. Kitashima and Miyajima: Studien ueber die Tsutsugamushi—krankheit. Kitasato Arch. Exp. Med., Vol. II, Nos. 2-3. Figures as follows: In text, 1-3; Taf. VI, all Figures; Taf. VII, Fig. 1; Taf. VIII, Fig. 1.

Trombicula formicarum Berlese.

1910. *Trombicula formicarum* Berlese. Brevi Diagnosi di Generi e Specie Nuovi di Acari. Redia, Vol. VI, p. 369.
 1912. *Trombicula formicarum* Berlese. Trombidiidæ. Redia, Vol. VIII, pp. 90-91, Fig. 41.

Trombicula canestrinii (Buffa).

1899. *Trombidium canestrinii* Buffa. *Trombidium canestrinii*, n. sp. Atti Soc. Vento Trent. di Sc. Nat. See Canestrinii Prospekt. Acarof. Ital., Vol. VIII, pp. 975-977, Pl. C.
 1912. *Trombicula canestrinii* (Buffa). Berlese: Trombidiidæ, Redia, Vol. VIII, pp. 88-90, Fig. 40.